Research on Magnetic Activated Carbon by XPS

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Abstract XPS(X-ray photoelectron spectroscopy) spectrometer EscA-750 was used to analyse the surface character of activated carbon, magnetic reagent and magnetic activated carbon. The distribution and change of C valence of them were determined. The conclusion is that the magnetic reagent could be adsorbed on the surface of activated carbon chemically, the interpretation of adsorptive mechanism of magnetic reagent in microstructure was discussed.

Key words: Magnetic reagent, Activated carbon, Magnetic activated carbon, X-ray photoelectron spectroscopy

Introduction

As one kind of important adsorbent, activated carbon was used in more and more fields. Magnetic activated carbon is becoming an interesting subject for solving separation of activated carbon in this field. Magnetic activated carbon which use magnetic reagent and activated carbon as raw material has many advantages[1] such as giant specific surface, well-distribution and firmly-combined magnetism. But the adsorptive mechanism of the magnetic reagent on activated carbon is still unknown.

X-ray photoelectron spectroscopy(XPS) was a kind of vacuum analytical technology, which is sensitive to chemical state of element. It can provide composite and state information of atomic to tens of angstrom (A°) of solid surface.

In this paper, EscA-750 was used to analyze the change of valence and the distribution of C element of magnetic monosodium glutamate activated carbon and magnetic golden activated carbon. The adsorptive mechanism of magnetic reagent was disscussed.

Materials and Methods

MR-20, GH-14(monosodium glutamate activated carbon), JX-102(golden activated carbon), and tow kinds of magnetic activated carbons, MGH-14 and MJX-102 which used GH-14 and JX-102 as raw material respectively were used as experimental materials. The physical indexes of these raw materials were shown in Table 1.

Table 1. Physical indexes of materials

Number	Name	Magnetic Susceptibility /emu·g^{-1}	Hardiness (%)	Moisture (%)	Ash (%)	Methylene-blue, (mL)	Iron (%)	Chloride (%)	Acid soluble (%)	Iodine /mg·g^{-1}
1	MR-20	-	-	-	-	-	-	-	-	-
2	JX-102	6.071	98	4.28	0.76	-	0.10	0.02	2.47	1045
3	MJX-102	501	98	4.25	5.12	-	0.95	0.05	2.59	994.6
4	GH-14	4.241	98	3.90	0.60	13.1	0.02	0.01	0.47	-
5	MGH-14	594	98	3.83	1.81	10.5	0.85	0.05	2.58	-

In this research, modern analytical apparatus equipment(Esca-750) was used. Its working condition is: Ray voltage is 8 KV, Electric current 30 mA. Computer date processing system was used to process data.

Firstly, we synthetised magnetic reagent MR-20, take MR-20 as raw material to synthetise activated carbon, and then use EscA-750 to determined C element. Before XPS research, every sample must be treated by Ar-surface splashing clear. According to the measurements, we separated peaks for every obtained spectrum, combined the main curve by simulation, studied the changed regularity of C valence, and obtained the information about adsorptive mechanism.

Result and Discussion

As usual, for wood materials, valence of H element is stable, but C element change obviously[2]. C element is the main component of activated carbon. so, it is possible to analyze the adsoptive mechanism of MR-20 from the change of C valence.

C_{1s} spectrums of every sample were shown in Fig. 1. From Fig. 1, we can see that C_{1s} spectrum of magnetic activated carbon is not the simple addition of magnetic reagent's spectrum and activated carbon's spectrum. This means some chemical reactions might have happen between the contact surface of magnetic reagent and activated carbon. And these reactions produced some new functional groups.

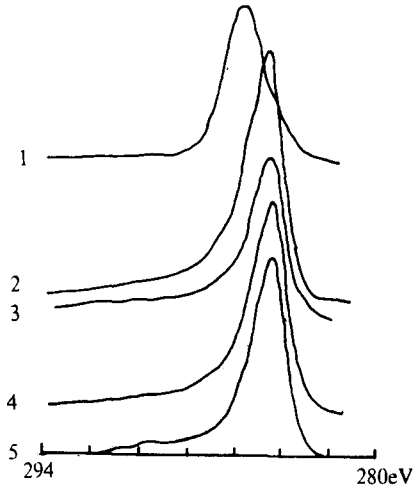

Fig. 1. Spectrums comparison of samples

Peak-separation of Spectrums

The peaks of the obtained spectrums of every sample were separated in order to determine the content variation of every functional groups of samples. For the sake of the length of paper, 4#, 5# samples peak-separation spectrums were given only(see Fig. 2 and 3). Concrete result of peak-separation was shown in Table 2 and 3.

In Table 2 and Table 3, C_1 is graphite kind of C atomics, C_2 is -C-C(or C - H bond) kind of atomics and in the same chemical state kind of C atomics, C_3 is -C-O- kind of atomics, C_4 is between -C-O- and $-\overset{O}{\overset{\|}{C}}-$ or O-C-O kind of atomics, C_5 is $-\overset{O}{\overset{\|}{C}}-$ or O-C-O kind of C atomics, C_6 is $-\overset{O}{\overset{\|}{C}}-O$ kind of atomics.

If there is no occurrence of chemical reaction between the contact surface of magnetic reagent (MR) and activated carbon, the content of their main functional groups should equal to the simple addition of source materials. That is, for 3# sample, C_2 should be between 96.04 and 49.98, C_6 should be between 3.96 and 6.91; For 5#, C_2 should be between 95.04 and 7.73, C_6 should be between 3.96 and 4.95. Content of C_1, C_3, C_4, C_5 should have no change with comparing to source materials. For 3# and 5#, the content of C_5 decreased, C_6 increased, C_4 changed differently, C_4 of 3# increased, 5# decreased(Table 3). From the chemical component of magnetic reagent(MR) and activated carbon's surface functional groups[3], it is concluded that some chemical reactions had happened between the contact surface of them. The reaction consume some functional groups and produce some new ones.

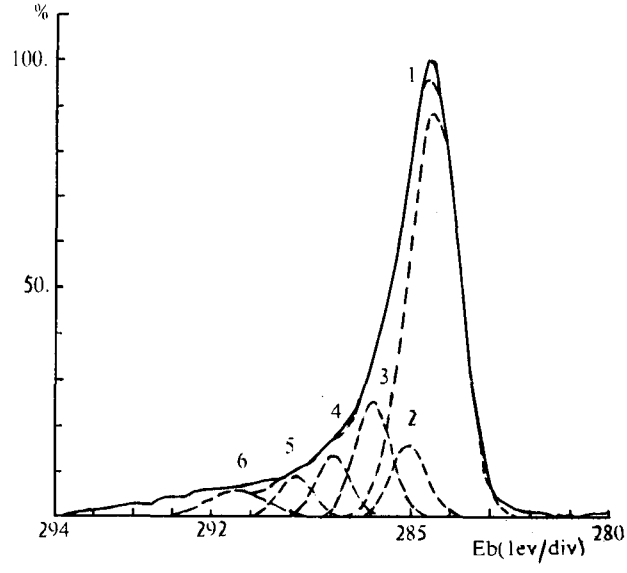

Fig. 2. 4# peak-separation spectrum

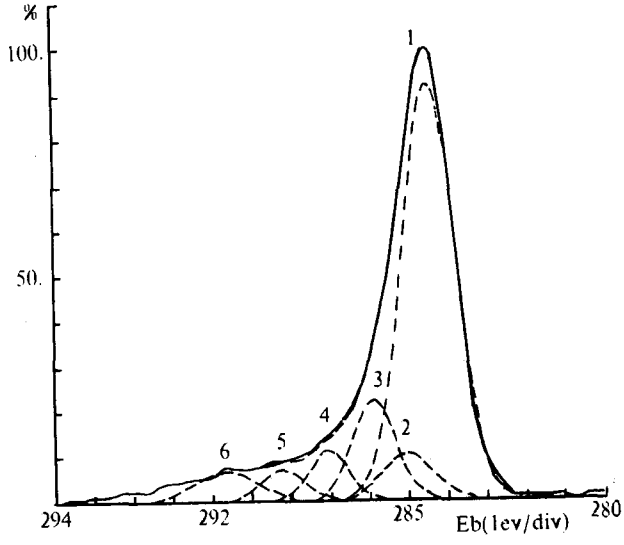

Fig. 3. 5# peak-separation spectrum

Table 2. Concrete peak-separation result

Sample number	peak number	1	2	3	4	5	6
1	PP / ev		285.60				289.60
	PH / %		9.34				2.77
	HW / ev		2.10				3.00
	PA / %		96.04				3.96
2	PP / ev	284.35	285.06	285.90	286.95	287.95	289.60
	PH / %	82.70	28.05	33.02	11.00	10.29	6.80
	HW / ev	1.30	1.00	1.30	0.90	1.10	2.20
	PA / %	13.18	49.98	19.95	4.68	5.30	6.91
3	PP / ev	284.35	385.00	385.80	286.85	587.70	589.45
	PH / %	87.39	30.89	33.42	14.20	11.31	8.18
	HW / ev	1.20	0.90	1.10	0.80	0.90	2.60
	PA / %	49.32	13.25	17.35	5.45	4.85	9.78
4	PP / ev	284.35	285.05	285.95	286.95	287.90	289.35
	PH / %	88.60	15.65	25.41	13.85	8.80	5.57
	HW / ev	1.50	1.00	1.00	0.90	1.00	1.70
	PA / %	64.60	7.73	12.55	6.19	4.35	4.59
5	PP / ev	284.85	285.05	285.90	287.05	288.20	289.65
	PH / %	92.00	10.06	22.00	11.00	6.84	6.29
	HW / ev	1.50	1.40	1.20	1.10	1.20	1.80
	PA / %	65.35	6.70	12.68	5.81	3.93	5.35

Note: PP: Peak Position and Combination Energy

PH: Relative Peak Height

PW: Half Wide of Peak

PA: Relative Peak Area and Relative Content of Every Functional Group

Table 3. Variation of relative content for main functional groups

Spectrum number	Name	C_1	C_2	C_3	C_4	C_5	C_6
1	MR-20		96.04				3.96
2	GH-14	49.98	49.98	19.95	4.68	5.30	6.91
3	MGH-14	49.32	13.25	17.35	5.45	4.85	9.78
4	JX-102	64.60	7.73	12.55	6.19	4.35	4.59
5	MJX-102	65.53	6.70	12.60	5.81	3.03	5.35

Conclusion

The chemical component of activated carbon's surface changed after magnetized. Thus, we can draw conclusion that some chemical reactions must have happened on the contact surface. The adsorption of magnetic reagent on activated carbon includes chemical adsorption. It is confirmed from indirect side that magnetic reagent and activated carbon combined firmly. The syhthetised magnetic activated carbon has great applied value in practice.

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